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Improving productivity of warm-season pastures by interseeding legumes

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Abstract: The dynamics of warm-season grass and legume plant communities are affected by grazing landscape and soil type. This project explored how these factors could be managed by western Iowa farmers to successfully establish higher-quality summer pastures comprised of warm-season grass/legume mixtures.

Question & Answer

Q: Can the productivity of warm-grass pastures be improved by interseeding legumes?

A: The results suggest that in western Iowa, interseeding switchgrass or big bluestem pastures with legumes has an adverse impact on the grasses due to early season competition from the legume. Stands of both warm-season grasses were significantly reduced by interseeding legumes, and for this reason it should not be a recommended practice.

Background

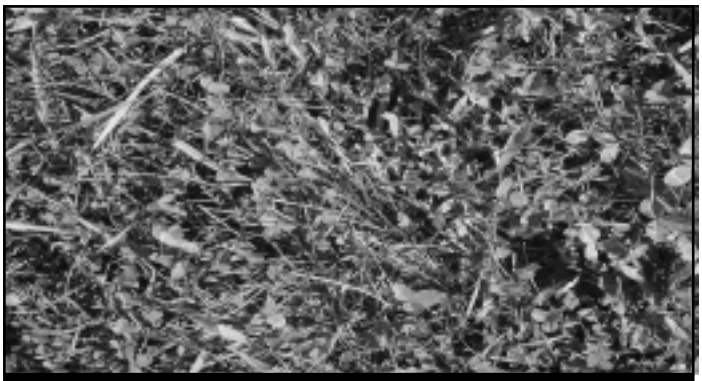
Uneven seasonal distribution of forage production from cool-season pastures during the grazing season is one of the main factors that limits animal production in Iowa pastures. Warm-season grasses can be used in summer pastures to complement cool-season pastures grazed in the spring and fall. However, cool-season grasses are higher quality forages than warm-season grasses. Growing legumes adapted for Iowa growing conditions in mixtures with warm-season grasses could improve the quality of forage available to grazing animals and reduce or eliminate nitrogen fertilizer requirements of the pasture.

The overall objective of this project was to improve the productivity of warm-season grass pastures for cattle production by interseeding a complex mixture of adapted legumes. Specific objectives were to:

1. Evaluate the impact of legumes on the productivity and quality of warm-season pastures grazed by growing cattle during summer,
2. Determine the site-specific adaptation of several legume species within landscape positions encompassed by the study, and
3. Develop strategies for optimum utilization of pastureland resources.

Approach and methods

A mixture of several legumes was interseeded into existing switchgrass and big bluestem pastures located at the Iowa State University Western Research Farm near Castana. The legumes planted represent species with varying life



Kura clover growing in a mixture with smooth bromegrass.

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$24,000 for year one
$24,650 for year two
$25,333 for year three

cycles (annual, biannual, and perennial) and growth habits (decumbent, erect, and plastic). The experimental design was a split plot with half of each pasture being renovated with legumes and the other half left in warm season grass. Pastures were strip grazed by growing beef cattle. Cattle weights were determined before and after the grazing season, and at intervals during the season. Pasture samples were collected at two-week intervals during grazing to determine the quantity and quality of available forage. Legume establishment and persistence were monitored by counts made at fixed positions within the landscape. Data were analyzed spatially to determine the relationships among the soil properties, landscape position, and legume recruitment and persistence.

Results and discussion

In general, cattle gains over the summer months provide evidence of improved pasture productivity. The grass/legume mixtures were expected to show the highest gains. For 1999 and 2000, big bluestem/legume pastures produced the largest gains, however, there was no substantial difference between bluestem/legume and other treatment effects or results during the first two years. Gains in 2001 were higher for grass pastures than those interseeded with legumes. Conversely, in 2002 the highest gains were generated by the grass/legume mixtures. Overall gains in 2001 were lower than in the first two years. This was due to the amount of forage available to the livestock; biomass was much less in 2001 than in other years over all treatments. One possible reason for differences in gain and biomass across the project time was the amount of precipitation received, which is important to consistent forage production.

Animal gains are related to more than just the type and amount of forage available; the quality of forage must be able to support animal production. Forage quality of pastures interseeded with legumes showed higher concentrations of crude protein (CP) for each year. Crude protein, digestibility (IVDMD), and lignin values were higher in grass/legume treatments for all years, but were not affected by the grass species. Although quality factors indicate that grass/legume treatments were relatively higher in overall forage quality than grass-only treatments, animal gains did not show the same results. However, some of the grass-only pastures did have significant volunteer legumes and cool-season grasses present. The encroachment of the cool-season grass along with precipitation levels may have exaggerated animal gains and reduced treatment differences over these three years. Cattle grazed these pastures during the summer when the quality of the cool season invaders was quite low.

In describing spatial patterns across pastures, analysis of species distribution and composition was of high importance. Because species growth and survival revolves around the environment, is it imperative to understanding the relationships and spatial distribution of pasture vegetation and pasture environment. Species composition of grass and legume/grass pastures was estimated over a two-year period. Grass/legume pastures showed a relatively high percentage (45 percent) of legumes, which indicates that they were reasonably well established. The overall composition of warm-season grasses was very low (ranging from 1 to 26 percent). A large percentage of pasture composition consisted of cool-season grasses. As for warm-season grass composition, significantly smaller amounts of these grasses were found in pastures containing legumes. There appears to be a negative relationship between the warm-season grasses and legumes in total pasture composition. Apparently, in these western Iowa pastures, legumes and cool-season grasses intercepted light and resources that impeded the growth of warm-season grasses. Although some of the species in the legume mix, such as alfalfa, appear to be adapted to the environment, they may not be ideal for use in a self-sustaining grass/legume pasture.

Data were collected along various landscape positions to characterize spatial distribution patterns of soil and species in pastures. Species composition was recorded along landscape positions. Legume composition was significantly lower along summit positions. Significant correlations along landscape positions indicate that by focusing resources to support grass growth on summit positions and concentrating on legume establishment on sideslope positions, it would be possible to manage pastures using site-specific techniques.

Conclusions

Interseeding warm-season grass pastures with legumes could potentially provide a number of benefits including improved forage quality, better seasonal distribution of forage, and reduced need for fertilizer inputs. These benefits have been verified in small-plot studies under hay management. However, under the growing and grazing conditions of this experiment, it was not possible

Aerial view of warm-seeded pastures interseeded witih legumes

to maintain acceptable stands of warm-season grass in mixtures with legumes. The legumes proved to be too competitive and greatly reduced stand density of the warm-season grasses. Even pastures not seeded with legumes experienced a significant invasion by cool-season grasses; predominantly smooth bromegrass. Based on the results of this study, interseeding warm-season grasses with legumes, at least on relatively productive soils, has a detrimental effect rather than the anticipated positive benefits. Under these growing and grazing conditions, it would be more advisable to maintain separate pastures of cool- and warm-season species. This latter system still benefits from the complementary growth of diverse species while eliminating interspecific competition.

The results of this experiment do indicate that forage legumes are well adapted to these growing and grazing conditions. Of the legume species planted, alfalfa, crown vetch, red clover, and white clover were present in the highest numbers across interseeded pastures. The persistence of these species indicates that they are well adapted to growth conditions in western Iowa.

Spatial variation of species composition was studied in relation to soil characteristics and landscape position. Previous research in Iowa has indicated that legume populations were associated with specific landscape positions. Results for the western Iowa pastures illustrated significant relationships between specific legume species and soil and landscape position. This information should be useful for designing multi-species pasture systems. Cool-season grass-legume mixtures should be seeded to pastures with soils and landscape positions best suited to their growth. Warm-season grasses maintained either as mixtures with other warm-season grasses or as monocultures should be seeded elsewhere in the landscape. Such an arrangement would provide improved seasonal forage distribution. Cattle would graze cool-season pastures in spring and fall, and the warm-season pastures during summer.

Impact of results

The results of this experiment demonstrate the complexity of managing pasture ecosystems to achieve a desired plant community. At the time legumes were interseeded into the warm-season grass pastures, the pastures were dominated

by their respective warm-season grass species. Prior to this project, significant effort has been made to reverse the encroachment of cool-season grass species using herbicides and grazing management. Establishment of legumes into warm-season grasses was very successful, so much so that the legumes were able to out-compete warm-season grasses for resources. Even in pastures where legumes were not seeded, cool-season grasses were able to successfully invade warm-season grass pastures under the deferred grazing management.

The apparent site-specific adaptation of forage species observed in this study offers the opportunity for better managing complex pasture communities. By developing a better understanding of the adaptation and inter-specific competition of forage species across landscape gradients, it should be possible to develop site-specific management practices that optimize the seasonal production and quality of pastures for improved livestock production.

Education and outreach

Nine publications were prepared discussing the project and its results.

For more information, contact
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